EECS 3201 Digital Logic Laboratory

Lab2: Seven Segment Displays

Objective

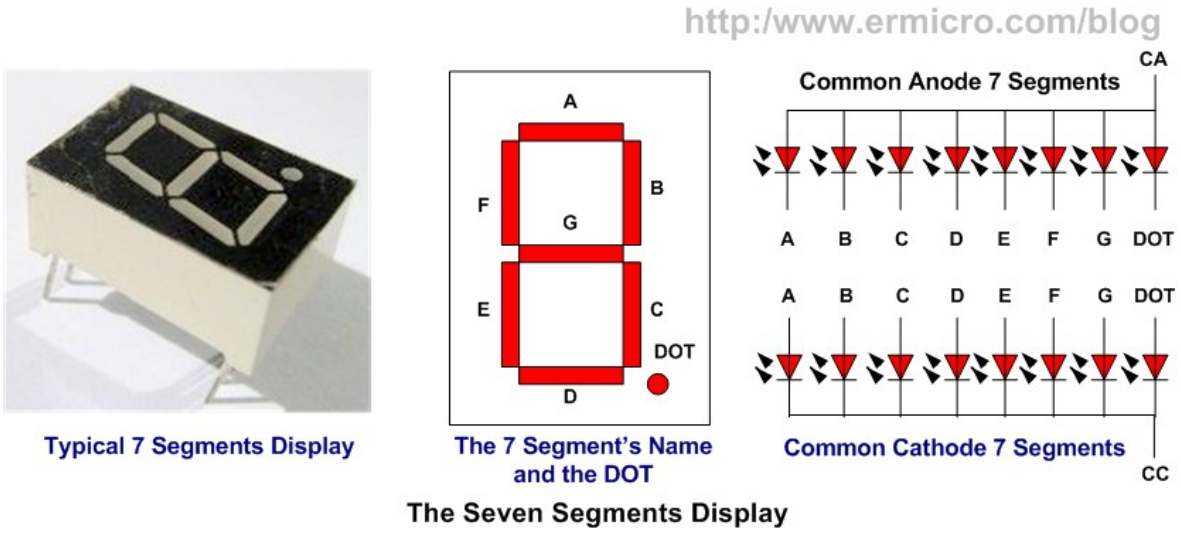
The objective of this lab is to gain experience using the seven-segment displays that we will use in later labs.

Reference Material

Altera DE10 manual and resources, available from the course web site.

Background

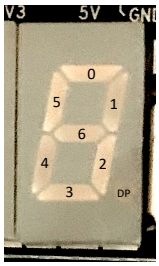
Seven segment LED displays are simple but effective and inexpensive information displays used in many embedded systems. Each display consists of an array of LEDs arranged in a pattern. When current flows through the diode it is illuminated. Typically, each diode is controlled by a single bit and either all the anodes or all the cathodes are tied together.



Typical 7 Segments Display

The 7 Segment's Name and the DOT

The Seven Segments Display



The above figure depicts a seven-segment display on the DE10-Lite, with seven LEDs (numbered 0, 1, …, 6), as well as a decimal point (DP). The LEDs can be illuminated to depict any hexadecimal number in 0,1,…,9,A,…,F. These numbers are shown below.

Each LED in the display has an associated binary function:

- The **input** to the function is a four-bit binary number, representing the hexadecimal digit 0 through F. For example, 0000 = 0, 0011 = 3, 0101 = 5, 1101 = D, etc.

To use the display, combinations of LEDs are switched on and off to represent a desired number. For example, to represent the number 4, LEDs number 1,2,5, and 6 are ON the rest are off.

Task

Design a circuit that displays, on one of the seven segments displays, the hex representation (0 to 9 plus A, b, C, d, E, and F) for the binary number represented by the a set of switches (your choice). For example if SW3 SW2 SW1 SW0 are 0100 (4) the 7-segment display should display the number 4, if they are 1110 then E should be displayed. **Note that a segment is illuminated by driving it with logic 0 (that is it is active low).**

1. Construct a truth table (4 inputs, 7 outputs, 16 rows) to show the relation between the switches and the LEDs.

2. Write a Verilog module implementing this set of Boolean functions. You can use the Verilog module from Lab 1 as a template. The difference is that we now have

four inputs and seven outputs; for each output, you can use an **assign** statement to assign the output to its function. In Verilog, the logical operators are ~ for NOT, | for OR, and & for AND. You can do this directly from the truth tables.

3. Make another version of your module modified so that it take one input and one output, where both input and output are defined as multi-bit buses.

4. Algebraically reduce at least one of your functions. **Fully and clearly explain your reduction in comments in the Verilog file.** For example:

```
// In minterm form, the function was originally f = ab~c +
abc
// Reduction:
// f = ab~c + abc
//   = ab(~c + c)
//   = ab(1)
//   = ab
assign f = a & b;
```

5. Assign the inputs to four of the switches (your choice which ones), and the outputs to one of the seven-segment displays (again, your choice). Pin labels are given in the DE10-Lite user manual.

6. Upload your circuit to the board, test (simulating your designs first is a good idea) and debug.

The implemented circuits must be demonstrated to the TA who will note a completed lab and ask questions about your design. When implementing the circuit be sure to use the switches and lights to make it easy to demonstrate your circuits.

Evaluation

Lab demonstration, in-lab explanations and answers, debug and test approach.
[2 marks for fully working]

Submitted Verilog modules with appropriate comments, structure, etc.
[2 marks for all functions implemented and documented correctly]